

# SC: Integrated Modeling of the Atmosphere-Ionosphere System

Goals is to enhance and extend the WACCM and WAM/IDEA models by creating state-of-the art software modules that:

- enhance the capability of the models to determine the impact of the “upward coupling”, and the consequences of “downward coupling”
- address critical science questions concerning the response of the lower atmosphere to solar variability, geomagnetic activity, and energetic particle precipitation
- quantify the impact of wave forcing in the lower atmosphere on ionospheric variability and structure
- provide new capabilities or refine the representation of important physical processes
- can be incorporated into the models with minimal modifications
- can run efficiently in parallel computing environments

**PI:** Rolando Garcia (NCAR)

**CU Institutional PI:** Tim Fuller-Rowell (CIRES)

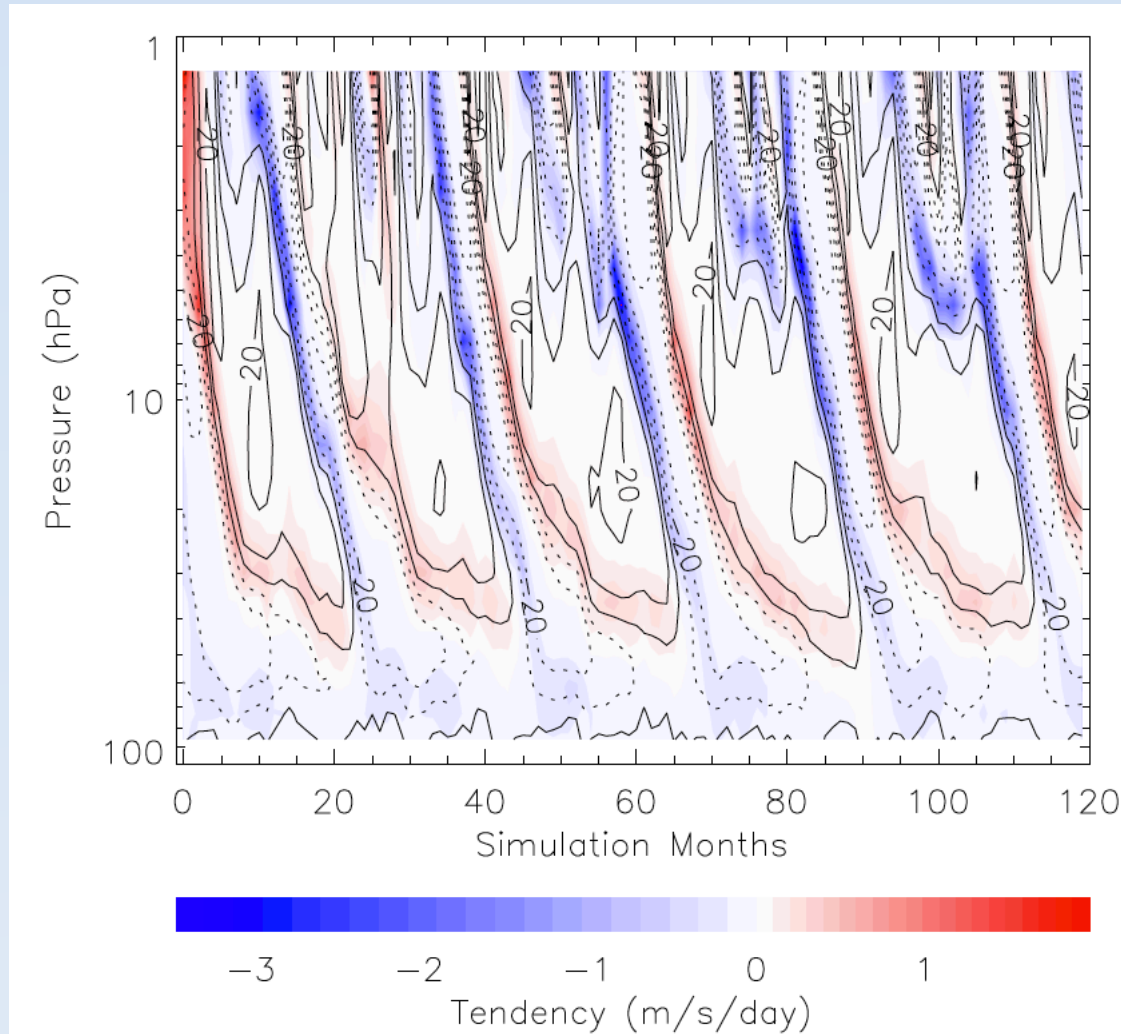
**NCAR Co-Is:** Hanli Lu, Daniel Marsh, Stanley Solomon, Arthur Richmond

**CU and NOAA Co-Is and Collaborators:** Juan Fontenla, Tomoko Matsuo, Houjun Wang, Rashid Akmaev, Mihail Codrescu, Cora Randall

**WACCM:** Whole Atmosphere Community Climate Model (NCAR), and extended version WACCM-X

**WAM/IDEA:** Whole Atmosphere Model/Integrated Dynamics though Earth's Atmosphere (CIRES/NOAA)

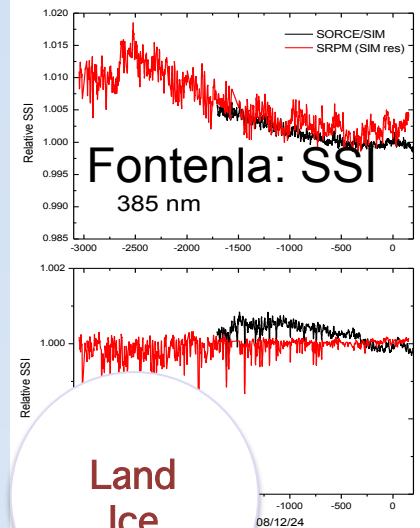
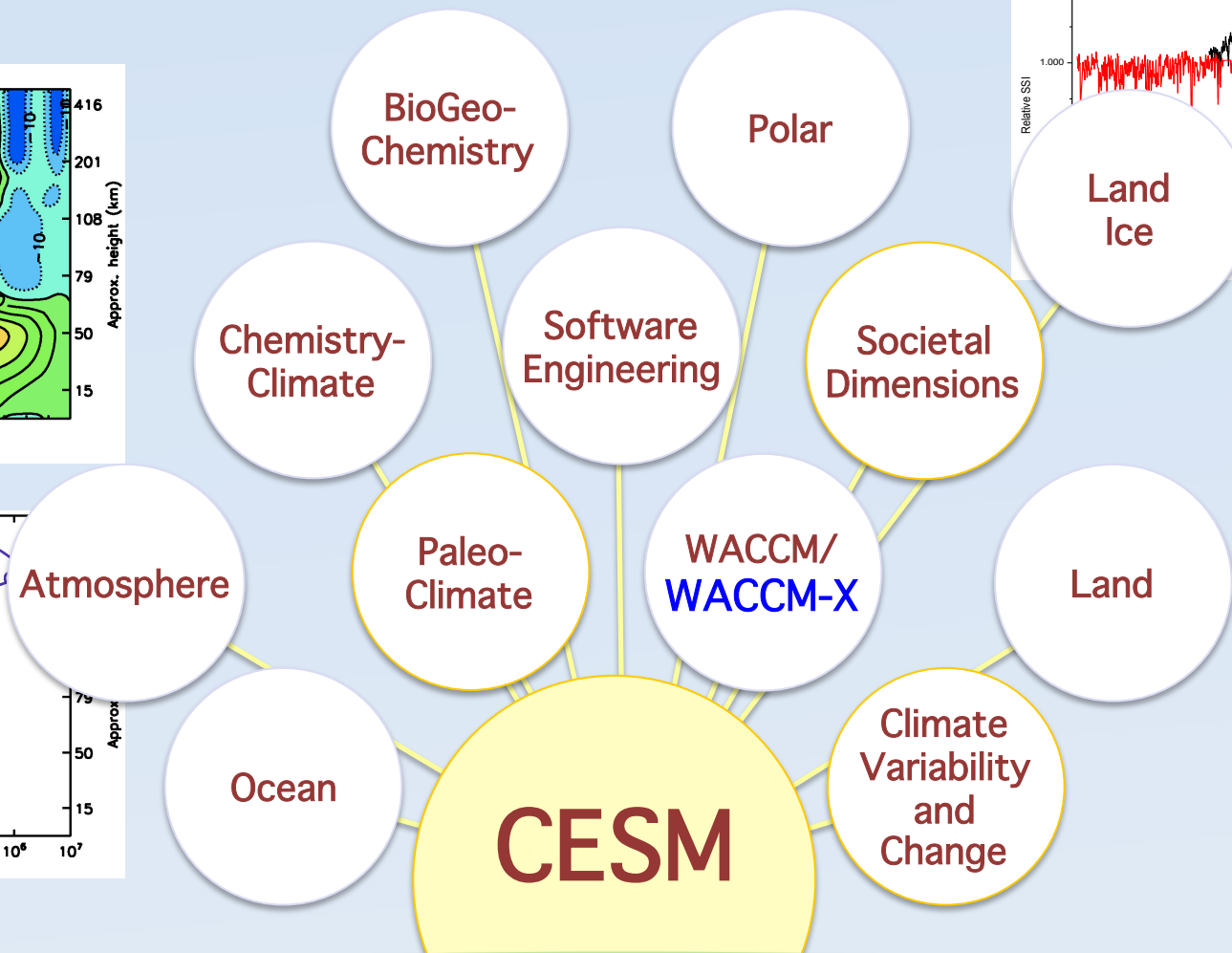
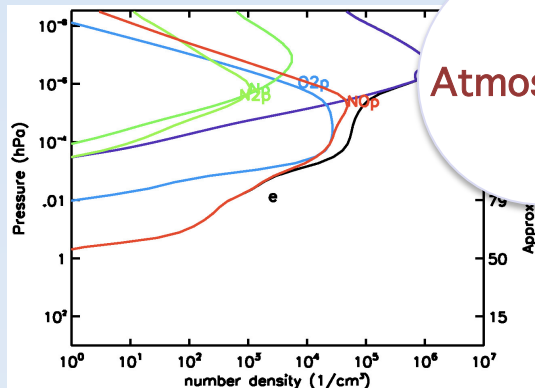
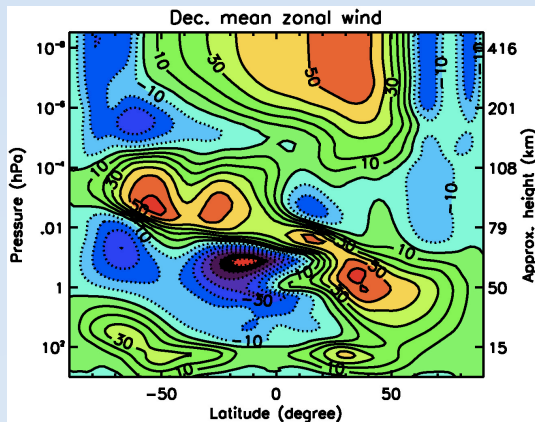
# Internally Generated QBO by IGW



Xue et al. (*JGR*, 2011, in press)

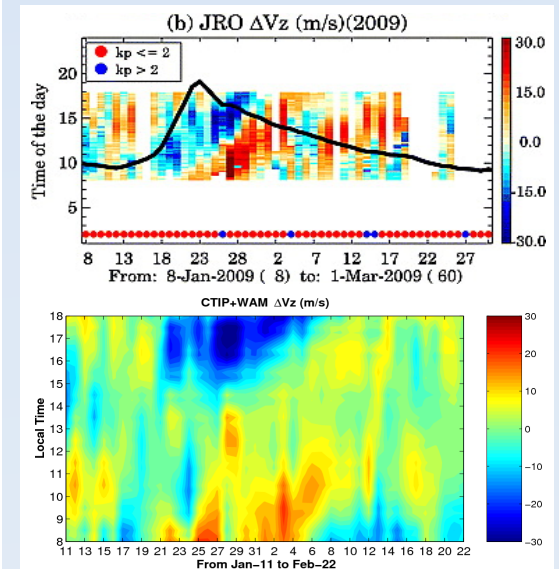
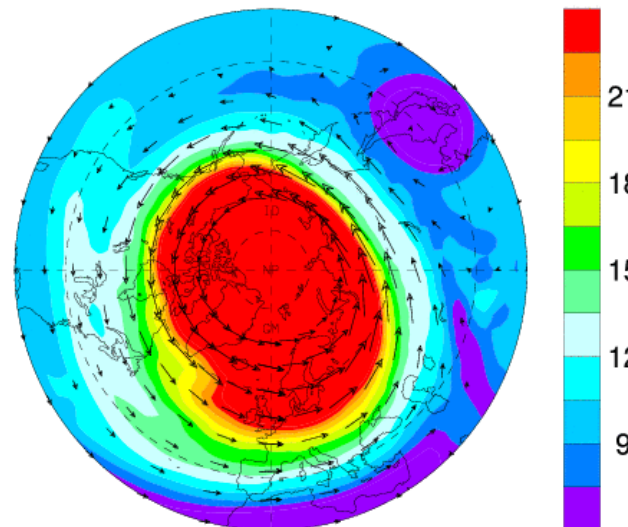
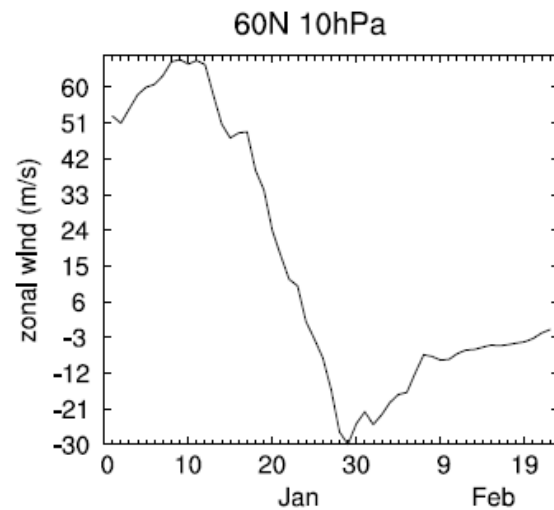
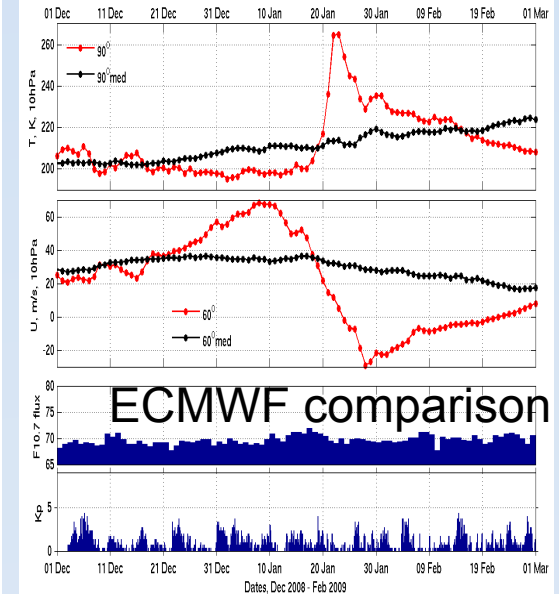
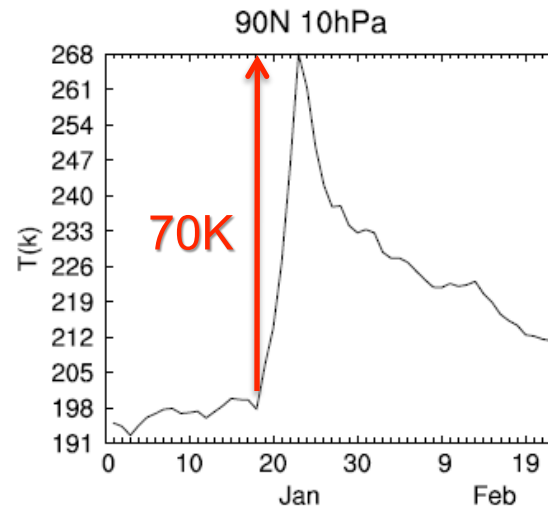
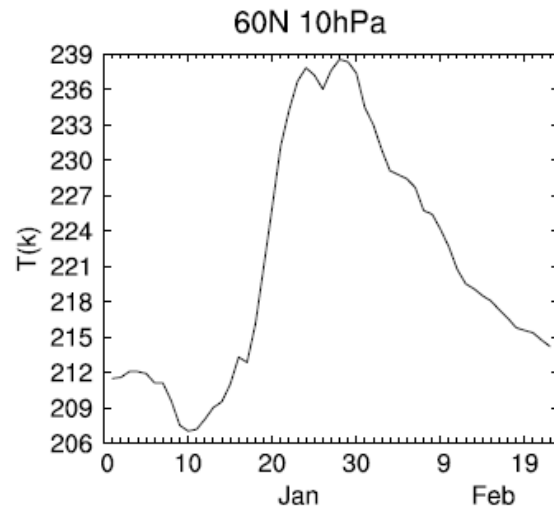
- Addition to the standard GW parameterization of WACCM
- Considers forcing by inertia-gravity waves (IGW; horizontal scale  $\sim 1000$  km)
- These waves have much lower saturation stress than mesoscale GW, and dissipate in the stratosphere  $\Rightarrow$  can force the QBO
- Improved dynamics is able to study two-way interaction between QBO and irradiance variations
- GW module is portable
- Will be incorporated into public versions of WACCM and WACCM-X to be released in 2012

# WACCM-X will be released as part of NCAR's CESM1.04 in Jan 2012



CESM: Community Earth System Model

# WAM simulation of the January 2009 SSW and electrodynamic response

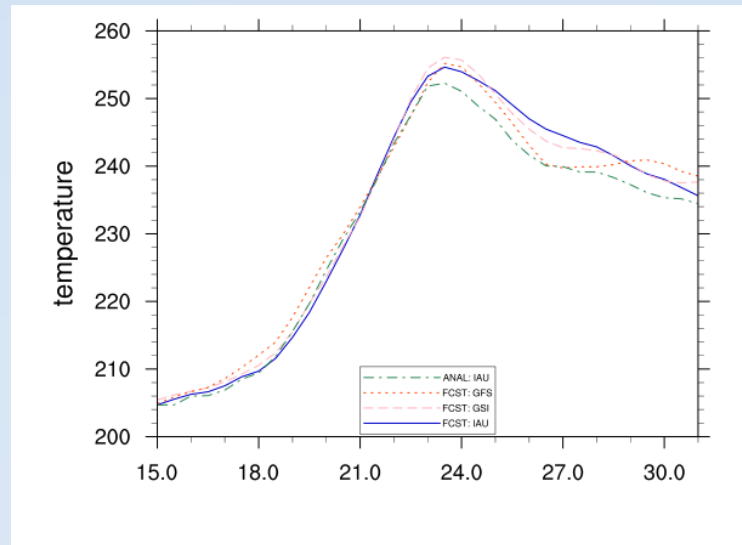


# Predictability

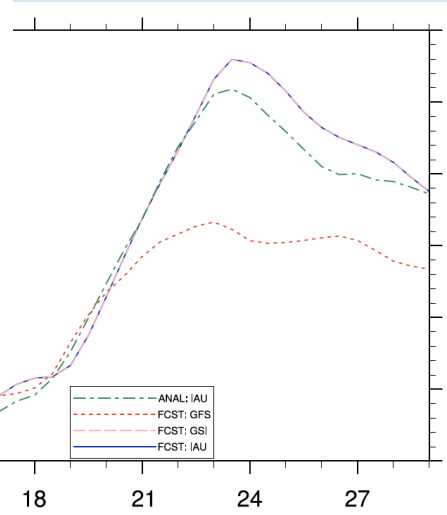
low resolution WAM: ~ 12 days

high resolution GFS: ~ 9 days

Initialized with operational data on  
Jan 15th



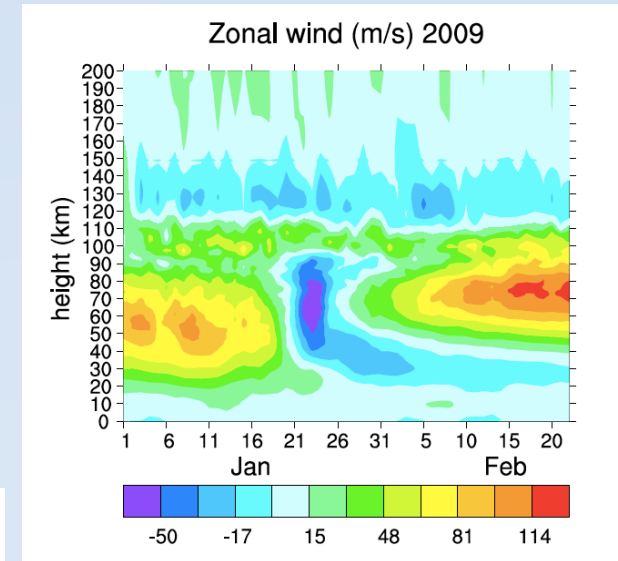
Jan 13<sup>th</sup>



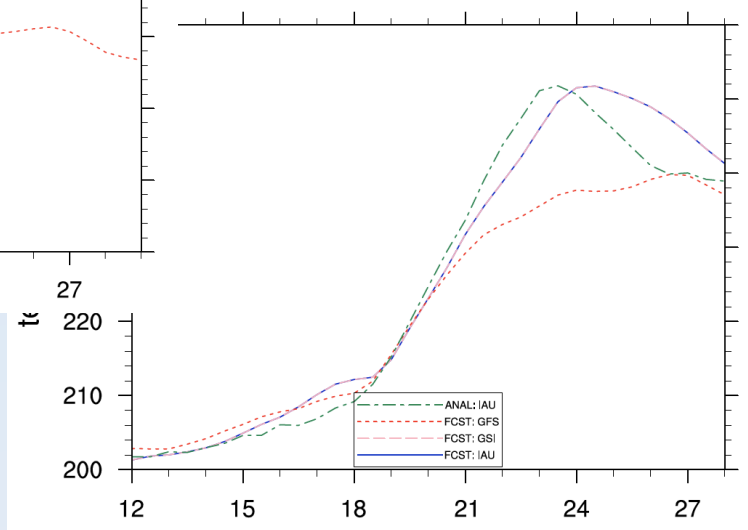
- When initialized with operational data, WAM is able to forecast the sudden stratospheric warming of Jan. 2009 several days in advance

Nov 8th, 2011

ISSI, Bern



Jan 12<sup>th</sup>



# Lessons Learned

- Strategic Capabilities funding is one of the very few opportunities to improve/finesse a modeling capability
- NCAR and CU Roles have been clearly defined at the start (upward and downward coupling themes) has led to efficient distribution of work
- Having two independent models (WAM and WACCM-X) has advanced both
- Team in one place (Boulder) has made communication easier
- Activity has already enabled some major advances